INSTRUCTION MANUAL

for

PANORAMIC

SPECTRUM ANALYZER
AND
MEASURING SET

MODEL PTT-1

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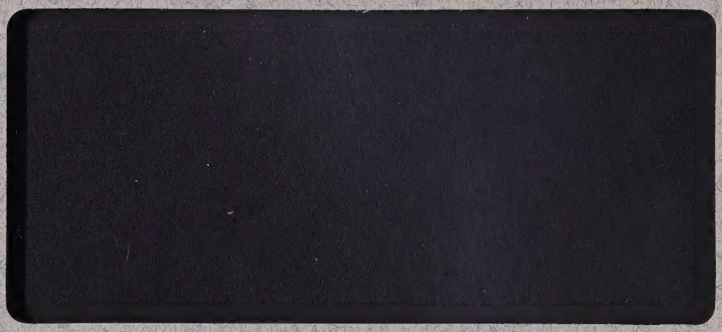

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SPECTRUM ANALYZER AND MEASURING SET

MODEL PTT-1

SECTION I
GENERAL DESCRIPTION

I-1. PURPOSE OF EQUIPMENT.

The Panoramic Spectrum Analyzer and Measuring Set, Model PTT-1, with its two plug-in modules RP-1 and SP-1, provides voice frequency measurement capabilities heretofore obtainable with several separate instruments. It is well suited to a wide variety of field and depot tests of telephone lines and networks. A large, directly calibrated CRT screen is used for automatic plotting of all PTT-1 test results. The horizontal axis is a frequency scale. Vertical deflection represents level in dbm, impedance in ohms, or return loss (db) depending on the test function used. Control functions are arranged for straightforward operation. Comprehensive self-checking provisions facilitate verification of PTT-1 calibrations.

The two interchangeable plug-in modules Models RP-1 and SP-1, fit into the main PTT-1 section which includes the CRT display facilities, input and output terminals, calibrated input and output attenuators, and the switches for operation function selection. With the RP-1 module, the PTT-1 comprises a sweep frequency generator and receiver for both straight-away and looped-back

measurements of lines, filters, repeaters and other VF networks. With the SP-1 plug-in module, the PTT-1 retains most of measurement capabilities available with the RP-1 module. A major exception is that tests requiring lock-in of the receiver to a remote signal generator, as in point-to-point transmission tests of long lines, can only be made with the RP-1. The SP-1 module also enables the PTT-1 to be used as a rapidly scanning spectrum analyzer for frequency and level measurements of signals in the voice frequency range. It is especially designed for convenience and accuracy in analysis of telegraph tones.

The PTT-1 with either RP-1 or SP-1 module, includes a signal generator which may be automatically or manually tuned and a tracking receiver-indicator section. The receiver section tracks the horizontal CRT deflection with the frequency of the internal generator or, with the RP-1 module, a remote signal source.

The signal generator outputs and receiver input terminals are balanced to ground. Each terminates in telephone type jacks Nos. 241, 309, and 310 as well as general-purpose twin binding posts. These are multipled together for convenience in testing. The generator output impedances are selectable at 600 and 900 ohms. In addition, a low impedance (< 15 ohms) output is furnished.

The receiver input impedances include 600 ohms, 900 ohms and a high impedance, exceeding 80,000 ohms.

To reduce dependence on external instrumentation, the PTT-1 is to a large extent self-checking. An internal zener diode stabilized source provides a regulated swept signal of 0 dbm. In level measurements, the 0 dbm level may be set to full scale as a reference. Tone rejection filters at 400 and 2,600 cps form sharp nulls in the generator output response to permit accurate checks of the frequency calibration. The 2,600 cps filter also prevents interference with the supervision features associated with 2,600 cycles signalling equipment used in toll and inter-toll circuits. The frequency scale accuracy can be checked at all points by reference to the calibrated RP-1 frequency dial in the manual tuning mode. Level calibrations are checked simply by the 5 db increments of the input and output attenuators.

The RP-1 module includes a direct reading 10 turn precision potentiometer which is used in impedance and return loss measurement for a 1% accurate reference. Three frequency markers for each telegraph channel are included in the SP-1 spectrum analyzer module.

The PTT-1 high persistence display may be adjusted for variable trace intensity and scale grid illumination to fit a variety of ambient

light conditions. Snap-in pencil transparancies are furnished for tracing of curves. A Polaroid oscilloscope camera which fits on to a camera bezel is also available for permanent records of PTT-1 displays.

I-2. APPLICATIONS.

The uses detailed below represent only a few of the many applications of the Model PTT-1. Inquiries are invited regarding the application of this instrument to particular requirements.

a. Response Plotting (either RP-1 or SP-1 module)

Level vs. frequency tracing: Insertion loss (or gain) referred to 0 DBM at 600 or 900 ohms) of voice frequency transmission circuits, networks, filters and repeaters is measured. The frequency response and the level are read directly from the calibrated screen. With the RP-1, automatic level comparisons and remote level tracing may be accomplished on a straight-away basis without a looped back circuit or line.

Impedance vs. frequency: The existence and absolute value of impedance irregularities caused by incorrect terminations, bridged taps, structural loadings, and other causes are readily detected. With the RP-1, comparison impedance measurements may also be made.

Return loss vs. frequency: Measurements may be made using the internal bridge hybrid for line versus network balancing. This includes those made on data, trunk, toll and office circuit balances as well as the return loss of Type E repeater and other VF networks. Return loss measurements may also be made using an external hybrid instead of the internal hybrid if desired. The overall effects of building-out capacitance at the terminal ends or at intermediate office locations may be easily determined. The phase angles of complex impedances can be measured accurately, using return loss techniques to determine them. The absolute value of the impedance magnitude is found by comparison with a standard variable resistor.

b. Spectrum Analysis (SP-1 Module)

VF telegraph system analysis: Overall display monitoring of one or more telegraph channels may be made on working systems without disturbing any of the channels. Individual FSK channels may be analyzed to determine the correctness of mark and space frequencies together with their levels. Crosstalk or interference between channels or systems can readily be observed. The frequency and level of the interference or crosstalk can be read directly from the screen and the deviation marker. Built in markers permit accurate signal level and frequency deviation

measurements to ± 1 cps for both 70 and 85 cps shift systems.

Voice Frequency Spectrum Analysis.

Speech Signal Studies.

Noise Level vs. Frequency plotted Pinpointing Excessive Levels anywhere within Band

Measurement of Harmonics, Distortion, Power Line Induction and other unwanted effects

Monitoring Pilot Tones and other signals

I-3. SPECIFICATIONS.

Specification	Module RP-1	Module SP-1
Frequency Range:	200 cps - 4000 cps linear scale	200 cps - 4 kc, linear scale
Sweep Widths (Frequency Excursion across Scale):	3800 cps	120 cps, 360 cps, 3800 cps
Center (of scale) Frequencies:	2100 cps	Pre-set at: 2.1 kc for overall scan from 200 cps to 4 kc. Also 255 cps, 425 cps, 595 cps, 765 cps, 935 cps, 1105 cps, 1275 cps, 1445 cps, 1615 cps, 1785 cps, 1955 cps, 2125 cps, 2295 cps, 2465 cps, 2635 cps, 2805 cps, 2975 cps, 3145 cps
Scanning Methods:	Automatic bi-directional scanning. Manual tuning.	Automatic scanning (rapid flyback) Manual, for 200 to 4000 cps range.

Scanning Times:	1.2 sec.	1 sec or 3 sec for 3800 cps sweep. 0.6 sec for 120 cps sweep width. 1.8 sec for 360 cps sweep width.
Output Levels:	+10 dbm, +5 dbm, 0 dbm, -5 dbm, -10 dbm, -15 dbm, -20 dbm, Re: 600 and 900 ohms	
Output Impedance:	Less than 15 ohms, 600 ohms, 900 ohms, balanced or unbalanced	
Generator and Receiver Level Deviation:	±0.1 db, re: 1000 cps	Same as RP-1
Generator Distortion:	Better than 40 db down from output signal level	
Scale Calibrations:		
Vertical Scales:	0-10 db, 0-20 db and 0-40 db linearly distributed. Impedance ranges: 100-1000 ohms, 200-2000 ohms, 400-4000 ohms, (separate screen furnished).	
Horizontal Scale:	200 cps - 4000 cps directly calibrated on linear scale	Same as RP-1 plus linear scale for 120 cps and 360 cps sweep widths
Resolution Capability: (Spectrum Analysis):	Not applicable	20 cps on 120 and 360 cps sweep widths
Input Required for Full-Scale Deflection:	+20 dbm, +15 dbm, +10 dbm, +5 dbm, 0 dbm, -5dbm -10 dbm, -15 dbm, -20 dbm Re: 600 and 900 ohms	
Minimum Useful Level:	-60 dbm	Same as RP-1
Undistorted Dynamic Range:	Not applicable	60 db on spectrum analysis. Virtually unlimited in response tracing.

Input Impedance:	600 ohms, 900 ohms, "High" (more than 80 K ohms)	
Return Loss Range:	0 - 60 db	Same as RP-1
Calibration References:		
Frequency -	400 and 2600 cps notch filters	400 and 2600 cps notch filters. Tuning fork controlled marker pips at all telegraph channel center frequencies and markers at ±42.5 cps from center. Signal Deviation control measures frequency separation of input signals from closest marker within ±1 cps.
Level -	Regulated 0 dbm potential re 600 or 900 ohms	
Impedance -	0 - 10,000 ohm resistance, ±1% accuracy	

GENERAL SPECIFICATIONS

Dimensions:	Approximately 10" w x 19-3/8" h x 21" d with panel cover lid in place.
Indicator:	Rectangular 6 inch cathode ray tube Type 6AFP7 (high persistence), adjustable scale illumination. Calibrated scale approximately 5-1/4" x 4-1/4".
Input and Output Terminations:	Types 241, 309, 310 and twin binding posts; multipled.
Trace Recording Provisions:	Snap-in pencil transparencies for each CRT scale. (Quantity furnished with PTT-1).

Polaroid oscilloscope camera and special mounting bezel (optional).

Power Requirements: 95-130 volts, 60 cps, approximately 150 watts. Approximately 7' long three wire AC line cord permanently connected to front panel.

Weight:

Main PTT-1 section:	53 lbs.
RP-1 module:	7 lbs.
SP-1 module:	11 lbs.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

SECTION II
OPERATING INSTRUCTIONS

II-1. GENERAL.

The Panoramic Spectrum Analyzer and measuring set, Model PTT-1 is a portable test set used for field and depot tests of telephone lines and networks. The Model PTT-1 automatically provides a direct crt display of the frequency and amplitude (level in dbm, impedance in ohms or return loss in db) of voice frequency circuits from 200 cps to 4,000 cps.

II-2. IDENTIFICATION OF FRONT PANEL CONTROLS.

All front panel control markings are color coded. Control markings in RED indicate positions which are used when calibrating the instrument prior to operation. Control positions marked in WHITE are operating positions, used when making measurements. Control positions marked in BLACK indicate that the markings apply to the smaller knob of a set of concentric controls.

a. Front Panel Controls, Model PTT-1, Main Section

The main section controls are physically divided into two main groups. The first group is adjacent to the cathode-ray tube. The second group, which is divided into three main sub-divisions, is located below the plug-in module area.

The functions of the main section controls are as follows:

1. POWER OFF/ILLUM(ination): This concentric switch/potentiometer control provides two functions. In the fully counterclockwise position a-c line power is removed from the entire instrument. Rotation of this control in a clockwise direction actuates the main power switch and applies a-c line power to the instrument. Continued clockwise rotation increases the illumination of the calibrated scale in front of the face of the crt.

In operation, this control may be adjusted for most comfortable viewing of the crt scale. When photographing crt screen traces, adjustment of the scale illumination may be necessary for best balance between crt trace intensity and crt scale illumination.

2. BRIL(liance): This control provides adjustment of the brilliance of the spot which forms the trace on the crt screen.

3. FOCUS: This control provides adjustment of the sharpness of the spot which forms the trace on the crt screen.

4. SCREWDRIVER-ADJUST CONTROLS: Four screwdriver-adjust controls are located immediately below the crt.

These controls are used when calibrating the instrument prior to making actual measurements. The circled red numbers which appear directly above these controls refer to the positions of the CALIBRATION switch marked with the same numbers. These controls are adjusted only when the CALIBRATION switch is in the corresponding position. Adjustment of these controls is covered in paragraph III-3, CALIBRATION. The functions of these controls are as follows:

(a) HOR(izontal POS(ition) ⑥. This control provides adjustment of the horizontal (side-to-side) position of the crt trace. Because the crt scale frequency calibrations are dependent upon horizontal position, and horizontal size (length), this control is adjusted in conjunction with the HOR(izontal) SIZE control on the Model RP-1 plug-in module.

(b) 0 DBM ③. This control is used to adjust the position of the crt trace for coincidence with the 0 DB crt scale calibration.

(c) V(ertical) SIZE ②. This control provides adjustment of the vertical size (height) of the spot which forms the trace on the crt screen.

(d) V(ertical) POS(ition) ①. This control is used to adjust the vertical (up-and-down) position of the trace on the crt screen.

The following controls are located below the plug-in module area. This group of controls is divided into three main sub-divisions. These are:

(a) SEND

(b) REC(eive)

(c) FUNCTION

4. SEND. This control is two switches on concentric shafts. Each switch is provided with a separate knob. These switches provide adjustment of the output of the generator appearing at the three multipled jacks immediately below the controls.

The larger knob, closest to the front panel, is a ten position switch which provides the following functions:

(a) CAL(ibration): This is a reference position, used when the Model PTT-1 is being calibrated prior to operation.

(b) DBM; -20, -15, -10, -5, 0, +5, +10. These seven positions are used to set the level of the signal generator output to the desired level. These seven positions are always used in conjunction with the $<15\Omega$ 600Ω and 900Ω positions of the small knob.

(c) R(eturn)L(oss). This position sets up appropriate levels to provide correct crt screen calibrations when making return loss measurements.

(d) IMP(edance) This position sets up appropriate levels to provide correct crt screen calibrations when making impedance measurements.

The smaller knob is a six position switch which provides the following functions:

(e) CAL: This is a reference position, used when the Model PTT-1 is being calibrated prior to operation.

(f) $<15\Omega$: This position is used to set the impedance of the signal generator output to less than 15 ohms.

(g) 600Ω : This position is used to set the impedance of the signal generator output to 600 ohms.

(h) 900 Ω : This position is used to set the impedance of the signal generator to 900 ohms.

(i) R(eturn) L(oss). This position sets up the appropriate output impedance when making return loss measurements.

(j) IMP(edance). This position sets up the appropriate internal output impedance when using the Model PTT-1 to make impedance measurements.

5. REC(eive). This control is two switches on concentric shafts. Each switch is provided with a separate knob. These switches provide adjustment of the receiver input impedance and level appearing at the two multipled receiver input jacks immediately below the controls.

The larger knob, closest to the front panel, is an eleven position switch which provides the following functions.

(a) CAL(ibration) This is a reference position, used when the Model PTT-1 is being calibrated prior to operation.

(b) DBM; -20, -15, -10, -5, 0, +5, +10, +15 and +20. These nine positions provide the indicated attenuation of

the input signal. The 0 DB position corresponds to a full scale (0 db) deflection of the trace on the crt screen. In the minus positions, the indicated value is subtracted from the crt trace deflection. In the plus positions, the indicated value is added to the crt trace deflection.

(c) IMP(edance): This position sets up the appropriate internal impedance when using the Model PTT-1 to make impedance measurements.

The smaller knob is a three position switch which provides the following functions.

(d) 600Ω: This position is used to set the input impedance of the receiver to 600 ohms.

(e) 900Ω: This position is used to set the input impedance of the receiver to 900 ohms.

(f) >80 KΩ: This position is used to set the input impedance of the receiver to high (more than 80,000 ohms) impedance.

The switches used to set up the Model PTT-1 for the required measurements are grouped in the center of the area below the plug-in unit. These controls are:

FUNCTION (top center)

Scale/CALIBRATION (bottom center)

2600Ω FILTER

PHASE

The functions of these controls are as follows:

6. FUNCTION: This seven position switch provides the following functions:

(a) CAL(ibration). This is a reference position used when the Model PTT-1 is being calibrated prior to operation. The three positions labeled REC(eiver) LEV(el) are used when making level measurements of circuits connected to the REC(eiver) jacks.

(b) REM(ote) SEND. In this position the horizontal sweep of the trace on the crt screen is synchronized with the frequency of the signal connected to the REC jacks. The received signal governs both the horizontal (frequency) and vertical (level) deflections of the trace.

(c) LOCAL SEND. In this position, the horizontal sweep of the trace on the crt screen is synchronized to the signal appearing at the SEND jacks.

(d) COMP(aritive). In this position the responses of circuits connected to the STANDARD and UNKNOWN jacks are internally switched to appear on alternate scans of the crt trace.

The two positions labeled IMP(edance) are used when making impedance measurements of circuits connected to the UNKNOWN and STANDARD jacks.

(e) UNKNOWN: In this position the impedance of a circuit connected to the UNKNOWN jack is plotted by the trace on the crt screen.

(f) COMP(aritive). In this position the impedance of circuits connected to the STANDARD and UNKNOWN jacks are internally switched. The plots of the two impedances appear on alternate scans on the crt screen.

(g) R(eturn) L(oss). In this position a plot of the return loss of a circuit connected to the UNKNOWN jacks is displayed on the crt screen. The internal or external balancing impedance is connected to the STANDARD jacks when making this measurement.

7. CALIBRATION/Scale. This twelve position switch provides two main functions.

(a) The lower six positions, with red markings are used when the Model PTT-1 is being calibrated prior to operation. The function of each position is labelled in two ways. One marking described the function in words, the other marking appears as a number in a circle. Each number in a circle corresponds to the similarly marked screwdriver-adjust control or controls. Whenever, a screwdriver-adjust control is adjusted, the CALIBRATION switch must be in the position marked with the number corresponding to the control or controls being adjusted.

(b) The six upper positions are marked in white. The functions of these positions are as follows:

(1) The three positions marked DBM are used when making level and return loss measurements of circuits. In the position marked 10, the calibrated crt DB screen scale markings at the left hand side of crt scale A are used. In this case the top horizontal calibration represents 0 DB and the

bottom calibration represents 10 DB down. Intermediate values are read from the scale which is calibrated in 1 db steps.

In the position marked 20, the bottom horizontal calibration represents 20 DB down. In this case the intermediate values are read in 2 DB steps by doubling the number marked for each step.

In the position marked 40, the bottom horizontal calibration represents 40 DB down. In this case the DB calibrations on the right hand side of the crt scale are used.

(2) The three positions marked IMPEDANCE are used when making impedance measurements of circuits connected to the UNKNOWN jacks.

In the position marked ZX1/2 the calibrations on crt scale B are divided by two.

In the position marked ZX1 the calibrations on crt scale B are read directly.

In the position marked ZX2 the calibrations on crt scale B are doubled.

8. 2600∿ Filter. This two position rotary switch is used to insert a 2600 cycle notch filter in the generator output response to provide a check of frequency calibration. This filter also prevents interference with the 2600 cps supervisory signaling equipment used in toll and inter-toll circuits.

9. PHASE. This two position momentary lever switch is used to determine the impedance phase angle of networks when making return loss measurements.

(a) REF(erence). In this position, an internal phase sensing capacitor is bridged across the internal or external balancing impedance.

(b) SENSE. In this position the internal phase sensing capacitor is bridged across the network under test.

10. Three screwdriver-adjust controls are located in the FUNCTION area. These controls are used when calibrating the instrument prior to making actual measurements. The functions of these controls are as follows:

(a) SG. This control is used to adjust the output of the (SEND) signal generator to the correct level.

(b) SP. This control is used to adjust the sensitivity (gain) of the receiver when the SP-1 plug-in module is being used.

(c) RP. This control is used to adjust the sensitivity (gain) of the receiver when the RP-1 plug-in module is being used.

b. Front Panel Controls, Model RP-1 Plug-In Module.

1. VARIABLE RESISTOR. This control is a presicion ten-turn variable resistance, adjustable from 0 to 10,000 ohms. It is read with an accuracy of ±1%. This variable resistor is equipped with a lock which will prevent inadvertant movement

after the required resistance has been set. The indicated resistance is available at the OHMS jacks.

2. SWEEP. This two position rotary switch provides a choice of automatic or manual scanning though the frequency range of 200 cps to 4,000 cps. This switch provides the following functions:

(a) AUTO(matic). In this position the RP-1 generator automatically scans the 200 cps to 4,000 cps band of frequencies every 1.2 seconds with a bi-directional sweep. The frequency calibration is linear, but the scan speed is slowed at the low end to allow sufficient response time in low frequency circuits. The superposition of forward and return traces insures negligible errors due to scan speed.

(b) MANUAL. In this position the sweep drive motor is switched out and the frequency band of 200 cps to 4,000 cps is scanned by manual rotation of the FREQ(uency) KC dial. This manual mode of operation provides best accuracy in scans through frequencies where there are resonant conditions or long delay times.

3. FREQ(uency) KC. This tuning dial indicates the frequency of the generator output appearing at the SEND jacks. The dial is calibrated to read directly from 200 cps to 4 KC. Between 200 cps and 1 KC the dial is calibrated in 25 cps increments. Between 1 KC and 3 KC the dial is calibrated every 50 cps. Between 3 KC and 4 KC the dial is calibrated every 100 cps.

4. SCREWDRIVER ADJUST CONTROLS, MODEL RP-1. Four screwdriver adjust controls are located below the handle of the Model RP-1. These controls are used when calibrating the instrument prior to making measurements. The circled RED numbers which appear directly above these controls refer to the positions of the CALIBRATION control marked with the same numbers. These screwdriver-adjust controls are adjusted only when the CALIBRATION switch is in the numbered position corresponding to the circled red numbers. Adjustment of these controls is covered in paragraph III-3, CALIBRATION.

The functions of these controls are as follows:

(a) 0.4 KC. This control is used to adjust the output of the generator section to 0.4 KC when the FREQ(uency) KC tuning dial is set to .4 KC.

(b) 2.6 KC. This control is used to adjust the output of the generator section to 2.6 KC when the FREQ(uency) KC tuning dial is set to 2.6 KC.

(c) -40 DB. This control is used to set the crt screen trace (baseline) to coincide with the -40 DB crt screen calibration when the CALIBRATION/Scale switch is set to 40 DBM.

(d) HOR(izontal) SIZE. This control is used to adjust the horizontal size (length) of the trace on the screen of crt. The accuracy of the crt scale frequency calibrations are dependent upon the proper setting of this control.

II-3. CALIBRATION.

a. Connect the ac line cord to a 115 volt (nominal), 60 cps, single-phase power outlet.

b. Apply power to the equipment by rotating the POWER-OFF switch in a clockwise direction.

c. After allowing the equipment to warm up for at least one-half hour, set up the front panel controls as follows:

Control	Position
BRIL(liance)	Center of range
FOCUS	Center of range
SWEEP (RP-1)	MANUAL
FREQ(uency) KC (RP-1)	CAL (1.0)
SEND (both)	CAL
REC (large)	CAL
FUNCTION	CAL
All other controls	Any

d. In the following procedure the CALIBRATION switch is stepped to succesive positions. In each numbered position the screwdriver adjust control or controls bearing corresponding circled red numbers is adjusted to provide calibration of the Model PTT-1.

e. Set the CALIBRATION switch to position (1), VERT(ical) POS(ition). Adjust screwdriver adjust control (1), V(ertical) POS(ition) to place the crt trace in coincidence with the 5 db (mid-scale) line on the crt scale. (Exactly half-scale).

f. Set the CALIBRATION switch to position (2), VERT(ical) SIZE. Adjust screwdriver-adjust control (2), V(ertical) SIZE to place the crt trace in coincidence with the 0 DB (full scale) line on the crt scale. (Exactly full scale).

g. Set the CALIBRATION switch to position (3), 0 DBM. Adjust screwdriver-adjust control (3), 0 DBM, to place the crt trace in coincidence with the 0 DB (full scale)line on the crt scale.

h. Set the CALIBRATION switch to position (4), REC(eiver) GAIN. Adjust screwdriver-adjust control (4) RP (if the RP-1 module is being used) or (4) SP (if the SP-1 module is being used) to place the crt trace in coincidence with 0 DB (full-scale) line on the crt scale.

i. Set the CALIBRATION switch to position (5), SEND GAIN. Adjust screwdriver-adjust control (5), S(end) G(ain) to place the crt trace in coincidence with the 0 DB (full scale) line on the crt scale.

j. 1. Set the CALIBRATION switch to position (6) SCRN (screen) FREQ(uency).

2. Set the FREQ(uency) KC Dial to 2.6 KC.

3. Adjust screwdriver-adjust control (6), 2.6 KC for a maximum dip of the crt trace. Note that the trace will be deflected downward, completely off the crt screen. Set the control to the position approximately half way between the point where the trace disappears and reappears at the bottom of the screen.

4. Adjust screwdriver-adjust control (6), HOR(izontal) POS(ition) to place the crt trace in coincidence with the arrow

engraved on the crt scale half way between the 2.4 and 2.8 calibrations. Because the crt trace was moved off the crt screen in step 3, it will be necessary to "rock" the FREQ(uency) KC Dial above and below 2.6 KC to bring the trace back on the screen. Adjust the HOR(izontal) POS(ition) control so that the trace is equidistant from the arrow when the FREQ(uency) KC dial is above and below 2.6 KC.

5. Set the FREQ(uency) KC Dial to .4 (400 cps).

6. Adjust screwdriver-adjust control (6), 0.4 KC for a maximum dip of the crt trace.

7. Adjust screwdriver-adjust control (6) HOR(izontal) SIZE to place the crt trace in coincidence with the 400 cps screen calibration. The 400 cps calibration is indicated by an arrow at the base of the screen calibrations.

8. Recheck steps 2 through 7 and repeat as necessary to place the crt trace in the correct position for each setting of the FREQ(uency) KC Dial.

9. Change the settings of the front panel controls as follows:

SEND (large knob)	-20 DBM
REC(eiver) (Large knob)	+20 DBM
CALIBRATION	7 40 DBM

10. Adjust screwdriver-adjust control (7), -40 DB, to place the crt trace in coincidence with the -40 DB (bottom) line on the crt scale.

II-4. MEASUREMENT TECHNIQUES.

The Model PTT-1, with its manually or automatically swept modes of operation, provides a wide variety of tests of voice frequency lines and circuits. In either the swept or manually tuned modes, the generator frequency and receiver track to maintain the accurate frequency calibration on the crt scale in the range of 200 to 4000 cps. When the Model PTT-1 is used with the RP-1 plug-in module the receiver section includes a discriminator which produces a horizontal deflection voltage proportional to frequency. The discriminator is connected to either the generator output or to the output of the tested network in looped back tests.

a. Remote Level Tracing, Straight-Away.

The Model RP-1 plug-in module is used with the Model PTT-1 to trace level vs frequency where the sending end is remote from the receiving end. In such straight-away test the received signal governs both the horizontal (frequency) and vertical (level) deflections of the trace. The RP-1 discriminator output is a linear function of the received frequency. The input frequency may be derived from either a second Model PTT-1, or other source, at the sending end. Either

sweeping or non-sweeping voice-frequency generators may be used. However, the scan speed should not exceed that normally used with the Model PTT-1 to avoid error due to time delay.

The Model PTT-1 is designed for transmission level measurements over a 40 db range with 0 db referenced to 0 dbm at 600 ohms or 900 ohms the output is 1 mw. In the case of a 600 ohm load and 600 ohm output impedance, the voltage across the load is 0.775 volts rms. For a 900 ohm load and output impedance, the voltage across the load is 0.948 volts rms. When the low impedance output ($<$15 ohms) is used, the voltage is 6 db more than that for the 600 ohm output.

In both the 600 ohm and 900 ohm modes of operation, the generator output is adjustable from +10 dbm to -20 dbm in 5 db steps. In all cases the output is balanced to ground.

The following procedure is used to make level vs frequency measurements when the sending end is remote from the receiving end.

The remote generator may be the SEND section of a second Model PTT-1 or any voice-frequency generator with output distortion better than 45 db down from output level.

1. Connect the circuit to be measured to the appropriate REC(eiver) jacks.

2. Set the FUNCTION switch to REM(ote) SEND.

3. Set the REC(eiver) switch small knob to the appropriate impedance setting. Set the large knob to 0 DBM.

4. Set the CALIBRATION/Scale switch to 40 DBM.

5. Sweep the line or circuit under test with the remote generator. Note that either sweeping or non-sweeping generators may be used. However, the scan speed should not exceed that normally provided by the Model PTT-1.

The trace on the crt screen of the Model PTT-1 will display the level vs frequency characteristics of the circuit under test.

When the input to the circuit under test is 0 DBM and the REC(eiver) switch is set to 0 DBM, the top screen calibration represents 0 DB. When the REC(eiver) switch is rotated clockwise to the + positions, the indicated number of db's should be added to the screen scale. For example, in the +5 position the 0 DB calibration line represents +5 DB, the -5 calibration line represents 0 DB, the -10 calibration line represents -5 DB etc., etc.

When the REC(eiver) switch is rotated counterclockwise from 0 DB to the (-) positions, the indicated number of DB should be subtracted

from the screen scale calibrations. For example, in the -5 DBM position of the REC(eiver) switch the 0 DB screen calibration line represents -5 DB, the -5 calibration line represents -10 DB, the -10 calibration line represents -15 DB, etc., etc.

The horizontal sweep of the Model PTT-1 will be locked to the incoming signal as long as the input level is maintained at at least -40 DB.

b. Level Tracing, Looped Back Circuits.

When the input and output of a four terminal network are available locally, or when a return circuit can be used to complete the loop, the following procedure is used for making level vs frequency measurements.

1. Connect the circuit to be measured to the SEND and REC(eiver) jacks.

2. Set the FUNCTION switch to LOCAL SEND.

3. Set the SEND switch (large knob) to 0 DBM, set the small knob to the appropriate impedance.

4. Set the CALIBRATION/Scale switch to 40 DBM.

In this mode of operation the receiver tracks the generator to produce a deflection on the crt screen proportional to the level of the line under test.

The trace on the crt screen of the Model PTT-1 will display the level vs frequency characteristics of the circuit under test.

The output of the generator section of the Model PTT-1 can be varied by rotating the SEND switch (large knob) in a clockwise or counter-clockwise direction. The front panel markings indicate the output level for each position.

c. Level Comparisons.

Figure 1 illustrates the test set up for level comparison measurements. The values of resistors labeled R, should be 450 ohms for a 900 ohm load impedance, 300 ohms for a 600 ohm load. The value of R2 is 900 ohms for a 900 ohm load, 600 ohms for a 600 ohm load.

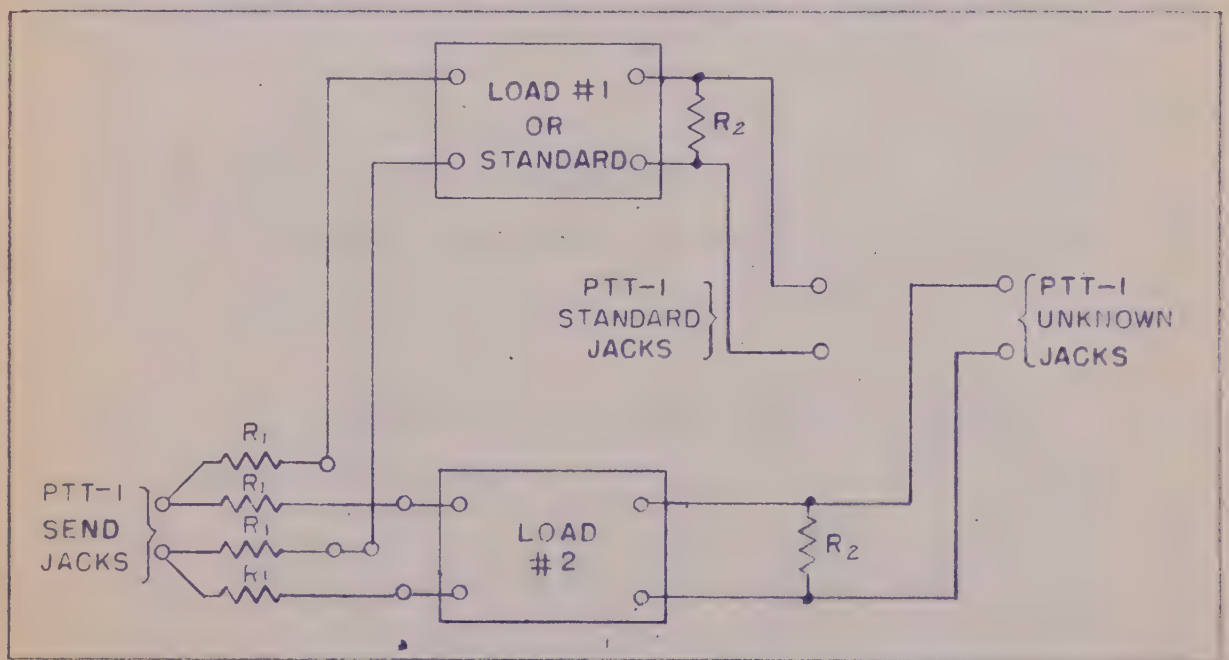

Figure 1. Level Comparison Test Setup.

1. Set the SEND switch (small knob) to <15Ω . Set the large knob to 0 DBM.

2. Set the FUNCTION switch to COMP(aritive).

3. Set the CALIBRATION/Scale switch to 40 DBM.

A comparison of the level vs. frequency characteristics of the two circuits under test will be displayed on the crt screen on alternate sweeps. When the crt beam is sweeping from right to left, one load will be displayed, on the return sweep from left to right, the second load will be displayed.

Operation of output and input level controls (SEND switch, large knob) and REC(eiver switch, large knob are the same as described in paragraphs a and b above.

d. Impedance vs Frequency Measurements.

To make impedance measurements with the Model PTT-1, use the following procedure.

1. Remove crt scale "A" (level) from the crt bezel. Install crt scale "B".

2. Set both knobs of the SEND switch to IMP(edance)

3. Set the FUNCTION switch to UNKNOWN IMP(edance).

4. Set the REC(eiver) switch (large knob) to IMP(edance) (The small knob is inoperative and may be set to any position.)

5. Set the CALIBRATION/Scale switch to one of the IMPEDANCE positions, depending upon the crt scale to be used.

6. Connect the circuit to be tested to the UNKNOWN jacks.

A plot of the impedance vs frequency of the circuit under test is displayed on the crt screen.

In the ZX1/2 position of the CALIBRATION/Scale switch the crt scale calibration range is from 1,000 ohms to 100 ohms. In this case all crt scale markings are divided by 2.
In the ZX1 position the calibration range is from 2,000 ohms to 200 ohms and the crt calibrations are read directly.
In the ZX2 position the calibration range is from 4,000 ohms to 400 ohms. The crt scale calibrations are read as multiplied by 2.

e. Impedance Comparison Measurements.

For measurements in which two lines are to be compared or a line is to be matched to an artificial network, etc., use the following procedure.

1. Set the FUNCTION switch to IMP(edance) COMP(ative).

2. Set the other controls to the positions listed in d above.

3. Connect the line to be measured to the UNKNOWN jacks.

4. Connect the artificial network to the STANDARD jacks.

A comparison of the impedance vs frequency characteristics of the two circuits will be displayed on the crt screen on alternate sweeps. When the crt beam is sweeping from right to left, one circuit will be displayed. On the return sweep from left to right semi-sum (1/2(S+X)) plot of the two circuits will be displayed.

f. Return Loss Measurements.

To make return loss measurements use the following procedure.

1. Install the "A" (level) crt scale in the crt bezel.

2. Set the SEND switch (both knobs) to R(eturn) L(oss).

3. Set the REC(eiver) switch (large knob) to 0 DB.

4. Set the CALIBRATION/Scale switch to 40 DB (or other scale as required).

5. Connect the network to be tested to the UNKNOWN jacks.

6. Connect the balancing impedance to the STANDARD jacks. The VARIABLE RESISTOR in plug-in module RP-1 is a source of known resistance for this measurement.

The display on the crt screen is a plot, in db, of the return loss of the network under test. The crt calibrated range is 0 db to -40 db. The sensitivity may be increased to -60 db in 5 db steps by rotating the REC(eiver) switch (large knob) counterclockwise. Maximum sensitivity is obtained when the REC(eiver) switch is set to -20 DB. In this case the crt scale reads from -20 to -60 db. However, because distortion in the Model PTT-1 generator output is better than 40 db down, under some conditions it is not possible to measure return loss better than -40 db.

the pioneer is the leader
Panoramic
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model
PTT-1

PANORAMIC SPECTRUM ANALYZER AND MEASURING SET MODEL PTT-1

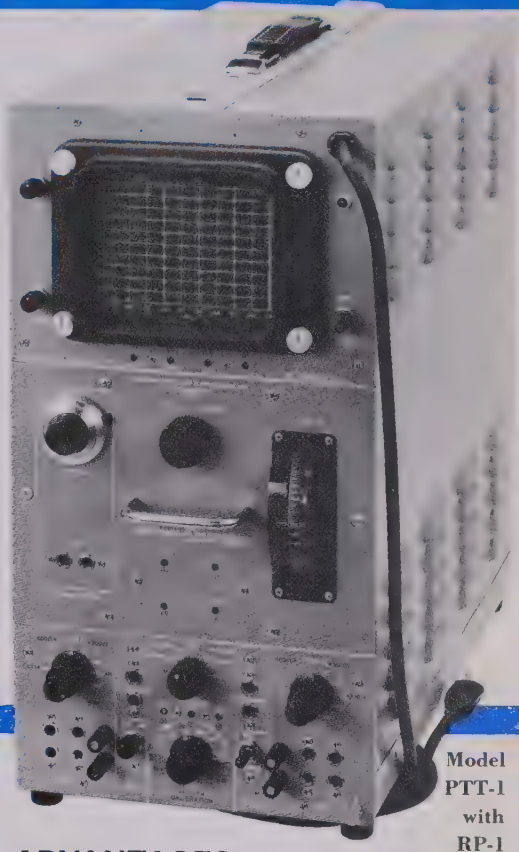
Versatile portable test set for Voice Frequency Circuits 200 - 4,000 cps

CALIBRATION OF TELEGRAPH MARK-SPACE TONES TO ±1 CPS AND ±0.2DB

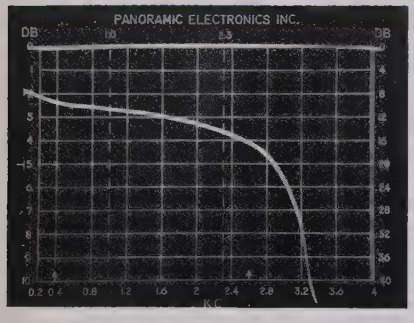
LEVEL VS. FREQUENCY TRACING, STRAIGHT-AWAY OR LOOPED BACK

IMPEDANCE VS. FREQUENCY PLOTS, ABSOLUTE AND COMPARISONS

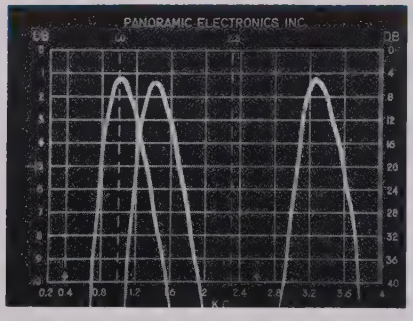
RETURN LOSS VS. FREQUENCY PLOTS AND LINE BALANCING



Model PTT-1 with RP-1 plug-in module



Telephone transmission line level vs. frequency test with PTT-1/RP-1. 0 DBM reference and test trace are alternately displayed.



Spectrum analysis of telegraph channel signals with PTT-1/SP-1. Marker pips are at plus and minus 42.5 cps from channel center.

GENERAL DESCRIPTION

The PTT-1, with its two plug-in modules RP-1 and SP-1, provides voice frequency measurement capabilities heretofore obtainable with several separate instruments. It is well suited to a wide variety of field and depot tests of telephone lines and networks. A large, directly calibrated CRT screen is used for automatic plotting of all PTT-1 test results. The horizontal axis is a frequency scale. Vertical deflection represents level in dbm, impedance in ohms, or return loss (db) depending on the test function used. Control functions are arranged for straightforward operation. Comprehensive self-checking provisions facilitate verification of PTT-1 calibrations.

continued on page 2

ADVANTAGES

- AUTOMATIC SWEPT BAND OPERATION REDUCES TEST TIME AND PRECLUDES MISSING CRITICAL FREQUENCIES. PRECISE MANUAL TUNING IS ALSO PROVIDED.
- THE PORTABLE PTT-1 IS WELL SUITED FOR FIELD AND LABORATORY MEASUREMENTS BY SEMI-SKILLED PERSONNEL.
- MEASUREMENTS ARE TRACED ON A LARGE 4¼" x 5¼" RECTANGULAR CATHODE RAY TUBE WITH **DIRECTLY READ CALIBRATIONS** ON ITS ILLUMINATED OVERLAY SCALES.
- UNIFORMLY SPACED 40 db, 20 db AND 10 db RANGE VERTICAL LOG SCALES AND 200 cps TO 4000 cps LINEAR FREQUENCY SCALES ARE SCORED ON SCREEN. MEASUREMENTS ARE SELF-CHECKED BY **INTERNAL** FREQUENCY, LEVEL, AND IMPEDANCE REFERENCES.
- PERMANENT COPIES OF PTT-1 DISPLAYS ARE MADE USING PENCIL TRACING TRANSPARENCY SNAP-INS OR WITH POLAROID OSCILLOSCOPE CAMERA.

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GENERAL DESCRIPTION

(continued)

The two interchangeable modules fit into the main PTT-1 section which includes the CRT display facilities, input and output terminals, calibrated input and output attenuators, and the switches for operation function selection. With the RP-1 module, the PTT-1 comprises a sweep frequency generator and receiver for both straight-away and looped-back measurements of lines, filters, repeaters and other VF networks. With the SP-1 plug-in module, the PTT-1 retains most of measurement capabilities available with the RP-1 module. A major exception is that tests requiring lock-in of the receiver to a remote signal generator, as in point-to-point transmission tests of long lines, can only be made with the RP-1. The SP-1 module also enables the PTT-1 to be used as a rapidly scanning spectrum analyzer for frequency and level measurements of signals in the voice frequency range. It is especially designed for convenience and accuracy in analysis of telegraph tones.

The PTT-1, with either RP-1 or SP-1 module, includes a signal generator which may be automatically or manually tuned and a tracking receiver-indicator section. The receiver section tracks the horizontal CRT deflection with the frequency of the internal generator or, with the RP-1 module, a remote signal source.

The signal generator outputs and receiver input terminals are balanced to ground. Each terminates in telephone type jacks Nos. 241, 309, and 310 as well as general-purpose twin binding posts. These are multipled together for convenience in testing. The generator output impedances are selectable at 600 and 900 ohms. In addition, a low impedance (<15 ohms) output is furnished. The receiver input impedances include 600 ohms, 900 ohms and a high impedance, exceeding 80,000 ohms.

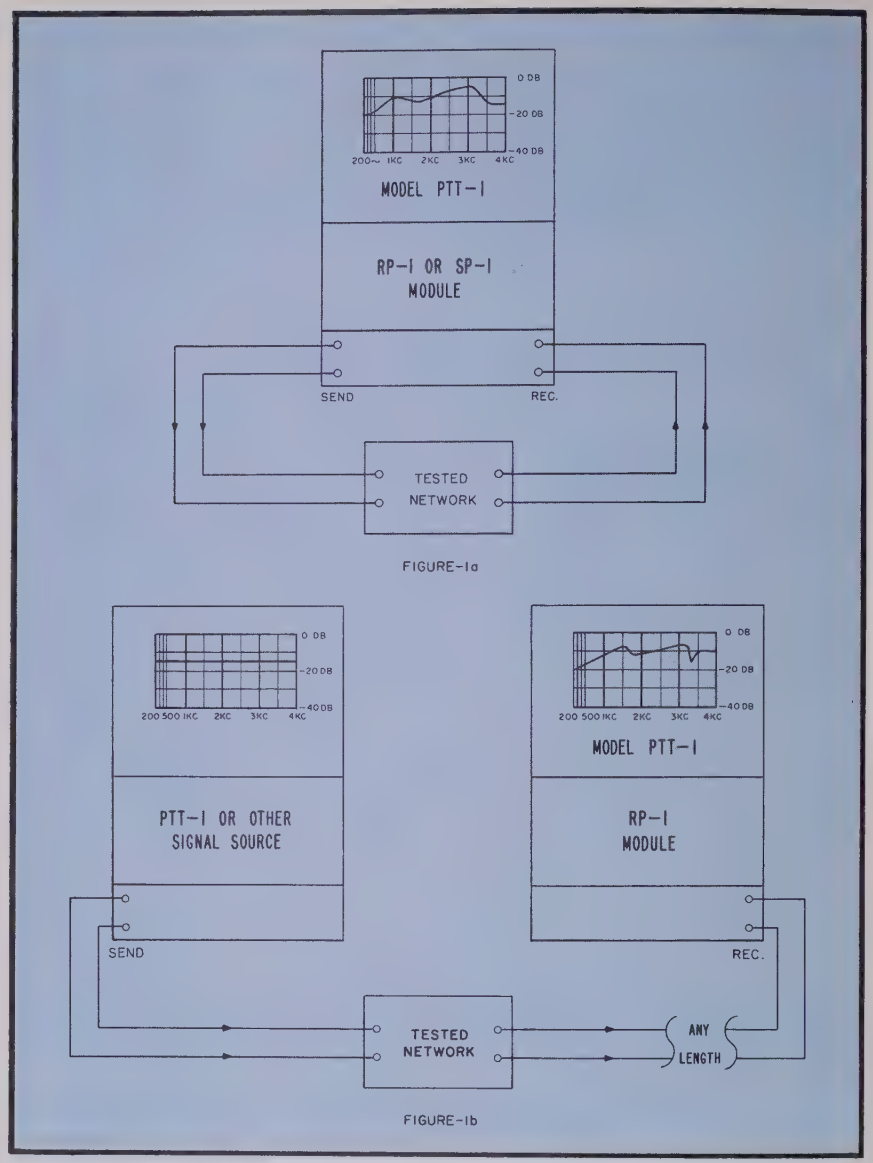


Fig. 1a—Hook up for loop-back level tracing. Fig. 1b—Hook up for remote, straight-away level vs. frequency tracing with PTT-1 with RP-1 module.

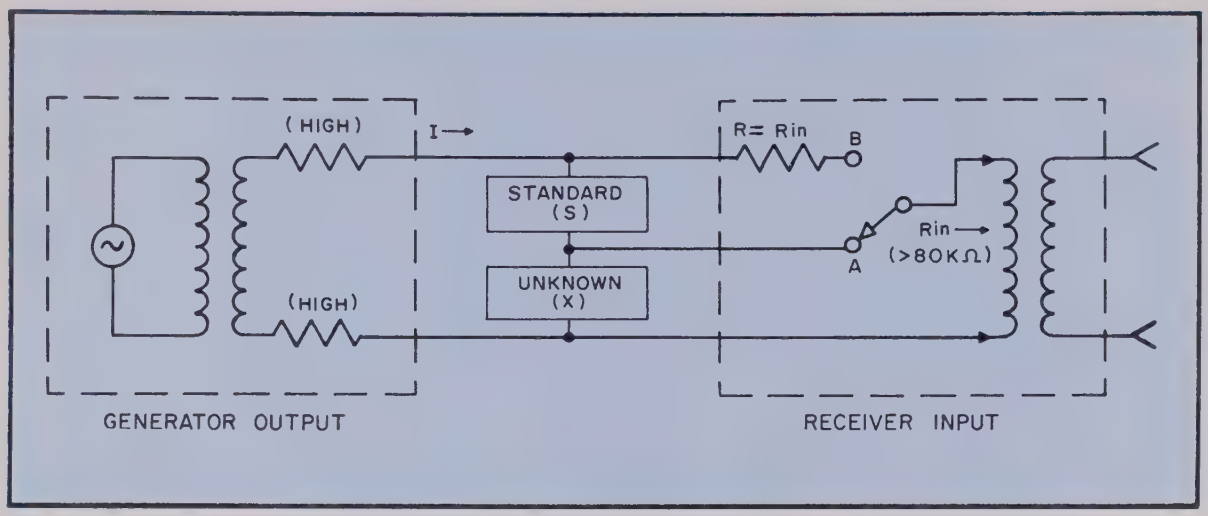
To reduce dependence on external instrumentation, the PTT-1 is to a large extent self-checking. An internal zener diode stabilized source provides a regulated swept signal of 0 dbm. In level measurements, the 0 dbm level may be set to full scale as a reference. Tone rejection filters at 400 and 2,600 cps form sharp nulls in the generator output response to permit accurate checks of the frequency calibration. The 2,600 cps filter also prevents interference with the supervision features associated with 2,600 cycles signalling equipment used in toll and inter-toll circuits. The frequency scale accuracy can be checked at all points by reference to the calibrated RP-1 frequency dial in the manual tuning mode. Level calibrations are checked simply by the 5 db increments of the input and output attenuators.

The RP-1 module includes a direct reading 10 turn precision potentiometer which is used in impedance and return loss measurement for a 1% accurate reference. Three frequency markers for each telegraph channel are included in the SP-1 spectrum analyzer module.

The PTT-1 high persistence display may be adjusted for variable trace intensity and scale grid illumination to fit a variety of ambient light conditions. Snap-in pencil transparancies are furnished for tracing of curves. A Polaroid oscilloscope camera which fits on to a camera bezel is also available for permanent records of PTT-1 displays.

DESIGN IMPROVEMENTS

TRANSMISSION MEASURING TEST SET MODEL PTT-1



IMPEDANCE VS. FREQUENCY PLOTS

The block diagram above indicates the improved impedance plotting method now used with the Model PTT-1 (superseding Fig. 2 on Page 4). When only the unknown (X) impedance is of interest, the switch is in "A" position and the voltage developed across the receiver input transformer is proportional to X. The generator current, I, is essentially constant inasmuch as the generator and receiver impedances are each much greater than the impedance of tested networks, 40-4000 ohms.

When the switch is in "B" position, the PTT-1 plots the magnitude of one-half the vector sum of the standard and unknown impedances, $(\frac{1}{2})$ (S+X). With the RP-1 module, the X and $(\frac{1}{2})$ (S+X) traces may be displayed alternately for convenient comparisons. If the S and X networks differ either in magnitude or phase, the $(\frac{1}{2})$ (S+X) value will differ from X. Spotting mismatch across the VF band is accomplished quite rapidly.

The voltage developed across S and X in series is divided equally between the dropping resistor, R, and the receiver input transformer to obtain the $\frac{1}{2}$ (S+X) plots. Note that the receiver input impedance exceeds 160,000 ohms when the half vector sums are plotted. The maximum error due to receiver loading (when S=X=4000 ohms) is less than 5% with this method. For lower values of S and X, the error is commensurately less.

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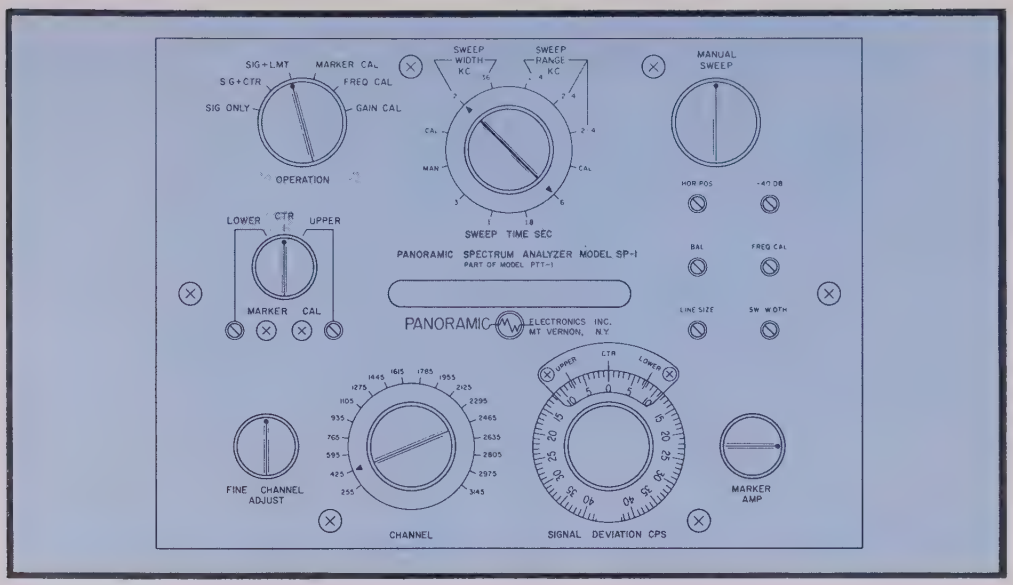


Control Detail, SP-1 Module

ADDITIONAL ADVANTAGES

- AUTOMATIC SWITCHING CIRCUITRY ENABLES ALTERNATE DISPLAYS OF STANDARD VS. UNKNOWN FOR PRECISE COMPARISONS IN LEVEL AND IMPEDANCE CHECKS AS WELL AS SPECTRUM ANALYSIS OF TELEGRAPH SIGNALS.
- AN INTERNAL PHASE SENSING CAPACITOR IS MOMENTARILY SWITCHED IN TO DETERMINE LAG OR LEAD SENSE OF COMPLEX IMPEDANCES.
- TWO SHARP NOTCHING FILTERS AT 400 cps AND 2600 cps IN THE SWEEP GENERATOR OUTPUT CIRCUITRY MAY BE SWITCHED IN FOR FREQUENCY CALIBRATION CHECKS. THE 2600 cps NOTCH AVOIDS INTERFERENCE WITH THE VF SIGNALLING TONE AT THAT FREQUENCY.
- VARIABLE SCAN SPEED USED WITH THE RP-1 MODULE, IMPROVES MEASUREMENT ACCURACY ESPECIALLY FOR CIRCUITS WITH CRITICAL TRANSMISSION LEVEL OR IMPEDANCE CHARACTERISTICS NEAR THE LOW END OF VF BAND.
- THE RP-1 MODULE INCLUDES A 10 TURN 10,000 OHM POT USED FOR A 1% ACCURATE IMPEDANCE STANDARD.
- THE SP-1 SPECTRUM ANALYZER MODULE PROVIDES FOR OVERALL ANALYSIS OF VF BAND TELEGRAPH SIGNALS AS WELL AS ENABLING PRECISE INDIVIDUAL TELEGRAPH CHANNEL MEASUREMENTS.
- SP-1 INTERNAL MARKERS CALIBRATE TELEGRAPH SIGNAL FREQUENCIES WITH 1 cps ACCURACY.
- SP-1 MODULE MEASUREMENT DYNAMIC RANGE COVERS 60 db.

APPLICATIONS

RESPONSE PLOTTING (EITHER RP-1 OR SP-1 MODULE)

LEVEL VS. FREQUENCY TRACING: Insertion loss (or gain) (referred to 0 DBM at 600 or 900 ohms) of voice frequency transmission circuits, networks, filters and repeaters is measured. The frequency response and the level are read directly from the calibrated screen. With the RP-1, automatic level comparisons and remote level tracing may be accomplished on a straight-away basis without a looped back circuit or line.

IMPEDANCE VS. FREQUENCY: The existence and absolute value of impedance irregularities caused by incorrect terminations, bridged taps, structural loadings, and other causes are readily detected. With the RP-1, comparison impedance measurements may also be made.

RETURN LOSS VS. FREQUENCY: Measurements may be made using the internal bridge hybrid for line versus network balancing. This includes those made on data, trunk, toll and office circuit balances as well as the return loss of Type E repeater and other VF networks. Return loss measurements may also be made using an external hybrid instead of the internal hybrid if desired. The overall effects of building-out capacitance at the terminal ends or at intermediate office locations may be easily determined. The phase angles of complex impedances can be measured accurately, using return loss techniques to determine them. The absolute value of the impedance magnitude is found by comparison with a standard variable resistor.

SPECTRUM ANALYSIS (SP-1 MODULE)

VF TELEGRAPH SYSTEM ANALYSIS: Overall display monitoring of one or more telegraph channels may be made on working systems without disturbing any of the channels. Individual FSK channels may be analyzed to determine the correctness of mark and space frequencies together with their levels. Crosstalk or interference between channels or systems can readily be observed. The frequency and level of the interference or crosstalk can be read directly from the screen and the deviation marker. Built in markers permit accurate signal level and frequency deviation measurements to ±1 cps for both 70 and 85 cps shift systems.

VOICE FREQUENCY SPECTRUM ANALYSIS.

SPEECH SIGNAL STUDIES.

NOISE LEVEL VS. FREQUENCY PLOTTED PINPOINTING EXCESSIVE LEVELS ANYWHERE WITHIN BAND.

MEASUREMENT OF HARMONICS, DISTORTION, POWER LINE INDUCTION AND OTHER UNWANTED EFFECTS.

MONITORING PILOT TONES AND OTHER SIGNALS.

MEASUREMENT TECHNIQUES

LEVEL TRACING OF COMPLETE LOOPS

Figures 1a and 1b illustrate use of the PTT-1 in the two basic level tracing connections. Fig. 1a applies when the input and output of a four terminal network are available locally or when a return circuit can be used to complete the loop. Either the SP-1 or RP-1 plug-in modules may be used in the complete loop connection. In either the swept or manually tuned modes, the generator frequency and the receiver track to maintain the accurate frequency calibration on the CRT scale from 200 to 4000 cps. With the RP-1, the receiver section includes a discriminator to produce a horizontal deflection voltage proportional to frequency. The discriminator input is connected to either the generator output or to the output of the tested network in looped back tests. When the tested network has a large delay time, it is preferable to use its output frequency to control the horizontal axis deflection as in straight-away tests, described below.

With the SP-1 module, the receiver tuning and the generated frequency are controlled by a common swept local oscillator ensuring exact synchronism. The selectivity of the SP-1 as a receiver in level tracing, eleminates responses to noise, power line induction, and harmonics, permitting precise level tracing at frequencies where the response is far below normal transmission amplitude.

REMOTE LEVEL TRACING, STRAIGHT-AWAY

As shown in Figure 1b, the PTT-1 receiver with the RP-1 module can be used to trace level vs. frequency where the sending end is remote from the receiving end. In such straight-away tests the received signal governs both the horizontal (frequency) and vertical (level) deflections of the trace. The RP-1 discriminator output is a linear function of the received frequency; which may be derived from either a second PTT-1, or other source at the sending end. Either sweeping or non-sweeping VF signal generators may be used. However, the scan speed should not exceed that normally used with the PTT-1 to avoid errors due to time display.

PTT-1 LEVEL TRACING CHARACTERISTICS

The PTT-1 is designed for transmission level measurements over a 40 db range with 0 db referenced to 0 dbm at 600 ohms or 900 ohms. Three switch selectable vertical decibels scales are furnished as shown on the screen photos. These are 0 −10 db, 0 −20 db, and 0 −40 db. Each is linearly distributed for simple, accurate interpolation. Generator output is adjustable from +10 dbm to −20 dbm in 5 db steps with 600 ohm and 900 ohm balanced terminals. A low impedence (<15 ohm) output is also furnished for tests where a voltage source is needed or where build out to a specific value is desired. Generator output level is flat within ±0.1 db over the band. Generator distortion is more than 40 db down from output signal level.

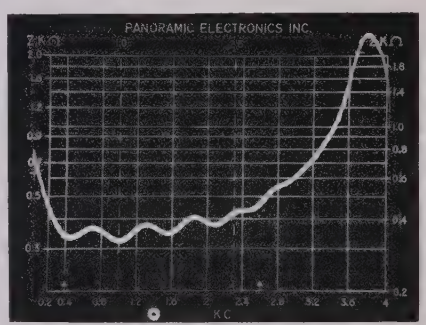
The RP-1 generator on its automatic mode of operation scans the 200 cps to 4 kc band every 1.2 seconds with bi-directional sweep. The frequency calibration is linear but the scan speed is slowed at the low end to allow sufficient response time in low frequency circuits. The superposition of forward and return traces ensures negligible errors due to scan speed. In scans through frequencies where there are resonant conditions or long delay time, the forward and return traces may not overlap. For these regions the manually tuned operation is required for best accuracy. The RP-1 tuning dial is accurately calibrated from 200 cps to 4000 cps and can be checked by the 400 cps and 2600 cps notch filters.

The SP-1 sweep generator includes pre-set switchable center frequencies, sweep widths, and sweep rates in its automatically scanning modes. Details on these scanning provisions are given in Specifications on the back page. The manual SP-1 tuning control is used to adjust the generator and receiver tuning at will anywhere within the 200 cps — 4000 cps spectrum.

The level indicating range of the PTT-1 is from −60 dbm to +20 dbm. Receiver input impedances are 600 ohms and 900 ohms balanced plus a very high (>80K) impedance terminal for non-loading connections across high impedance circuits such as in repeaters.

LEVEL COMPARISON

The front panel of the PTT-1 with the RP-1 contains input terminals for "Standard" and "Unknown" networks. When level comparison operation is selected, the two responses are internally switched to appear on alternate scans. Visual comparison even of small differences is facilitated by the high persistence trace.



VF line impedance plot covering 40 to 4,000 ohm range. Either RP-1 or SP-1 may be used (Scale x 2).

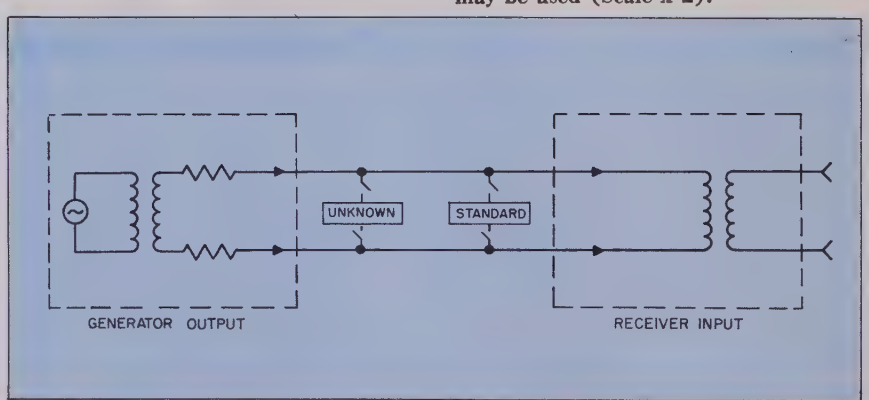


Fig. 2

PTT-1 block diagram for impedance vs. frequency plotting and for automatic impedance comparison tests.

IMPEDANCE PLOTTING

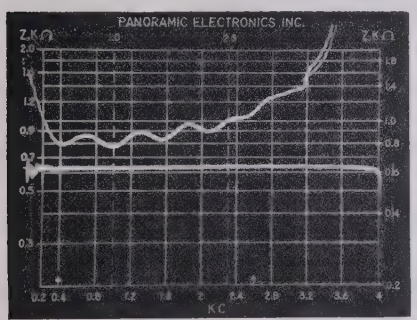
Figure 2 illustrates schematically the PTT-1 set up for quantitative impedance plotting. The balanced generator output is fed through large resistors (compared to load impedance) so that the current in the tested load is virtually proportional to the load impedance. The receiver input impedance exceeds 80,000 ohms so that it offers little loading. Cali-

brations are in ohms on the logarithmic vertical scales. Three separate impedance calibration scales are selectable by a front panel switch; i.e., 400 - 4000 ohms, 100 - 1000 ohms, and 200 - 2000 ohms. The impedance scales are similar in appearance and accuracy to the level tracing decibel calibration scales. A separate CRT overlay screen is furnished for impedance plots.

IMPEDANCE COMPARISON

Figure 2 also indicates the setup for comparison between the impedance of the network under test and a reference, or "standard" impedance. The same RP-1 double pole alternator circuitry is used as for level comparisons.

On the RP-1 module front panel there is a ten turn variable resistance adjustable from 0 - 10,000 ohms. It is read with an accuracy of ±1%. This resistance, or an external network can be used in impedance comparisons, return loss balancing, or for any other test requiring an accurate resistance value.



Two network impedances precisely compared over expanded 100—1,000 ohm range with RP-1 module (Scale x ½).

RETURN LOSS MEASUREMENT

Figure 3 is the signal flow diagram for return loss tests. The receiver section of the PTT-1 measures the voltage developed between the center point of the internal hybrid-winding, and the junction between the network under test and the balancing impedance. When the bridge is balanced, the receiver voltage is zero. The PTT-1 hybrid secondary is balanced by precisely matched resistors enabling return loss measurements to better than −60 db. Return loss is calibrated along the same decibel scales as for level tracing.

When a complex network under test is balanced against a resistance, the residual return loss is a direct measure of the impedance phase angle. A reference chart which relates phase angle and return loss is furnished with the PTT-1 instruction manual.

The sense of the phase, lagging or leading, is readily determined by momentarily switching in the capacitor shown on Figure 3, and noting whether the return loss increases or decreases. The capacitor is bridged across the known or standard impedances by means of a lever operated front panel switch.

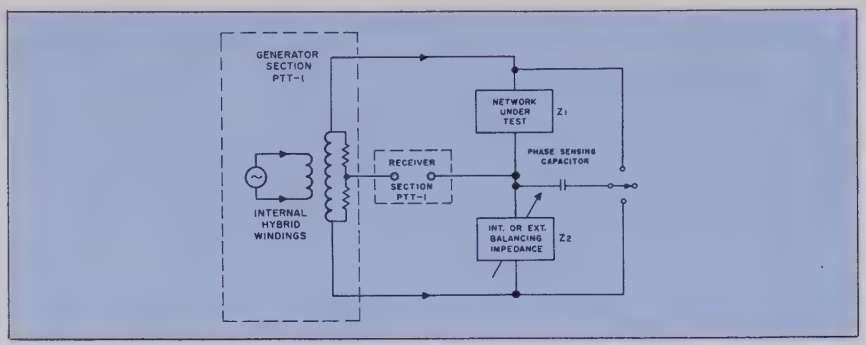


Fig. 3

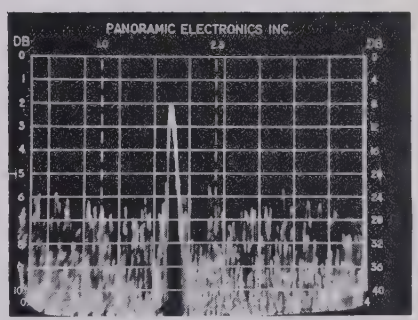
Return loss block diagram for PTT-1 with either module. Phase capacitor determines lag or lead of network under test. Internal precision 0—10,000 resistor may be used for balancing.

TELEGRAPH SIGNALS

With the SP-1 module, the PTT-1 displays the level and frequencies of telegraph tones as well as other VF signals. It may be set with a front panel switch for automatic scanning centered on any channel from center 255 to 3145 cps corresponding to the standard voice frequency telegraph channels. Scanning widths are adjustable in 3 steps; 1) analysis of one channel; ± 60 cps sweep about channel center frequency; 2) analysis centered on one channel plus part of the neighboring two channels; ±180 cps sweep and 3) an overall "quick look" scan from 200 cps to 4 kc which may also be manually tuned. Mark and space tones are displayed as pips (vertical deflections on the frequency scale) as shown on the screen photo on Page 1. On the 120 and 360 cps sweep widths, alternate marker and signal indications may be selected for calibration. Marker frequencies are located precisely at all channel centers and at plus and minus 42.5 cps from center. Either the ±42.5 cps markers or the center markers may be selected by a switch. A signal deviation control with a calibrated dial is used to bring the marker and signal pips which appear on alternate scans into frequency scale coincidence. The frequency difference between the signal and adjacent marker can then be measured within 1 cps using the 120 cps sweep width. Each marker pip deflection is of the same amplitude so that they may also be used as standard reference levels.

For the 120 cps sweep width, the SP-1 scan interval is 0.6 seconds, enabling easy appreciation of alternating display. For 360 cps sweep width, the scan time is 1.8 seconds. For the overall 200-4000 cps scan, a 1 second or 3 second scan interval is selectable. The analyzer is capable of visually separating signals as closely spaced as 20 cps on the narrow band 120 cps or 360 cps sweep widths.

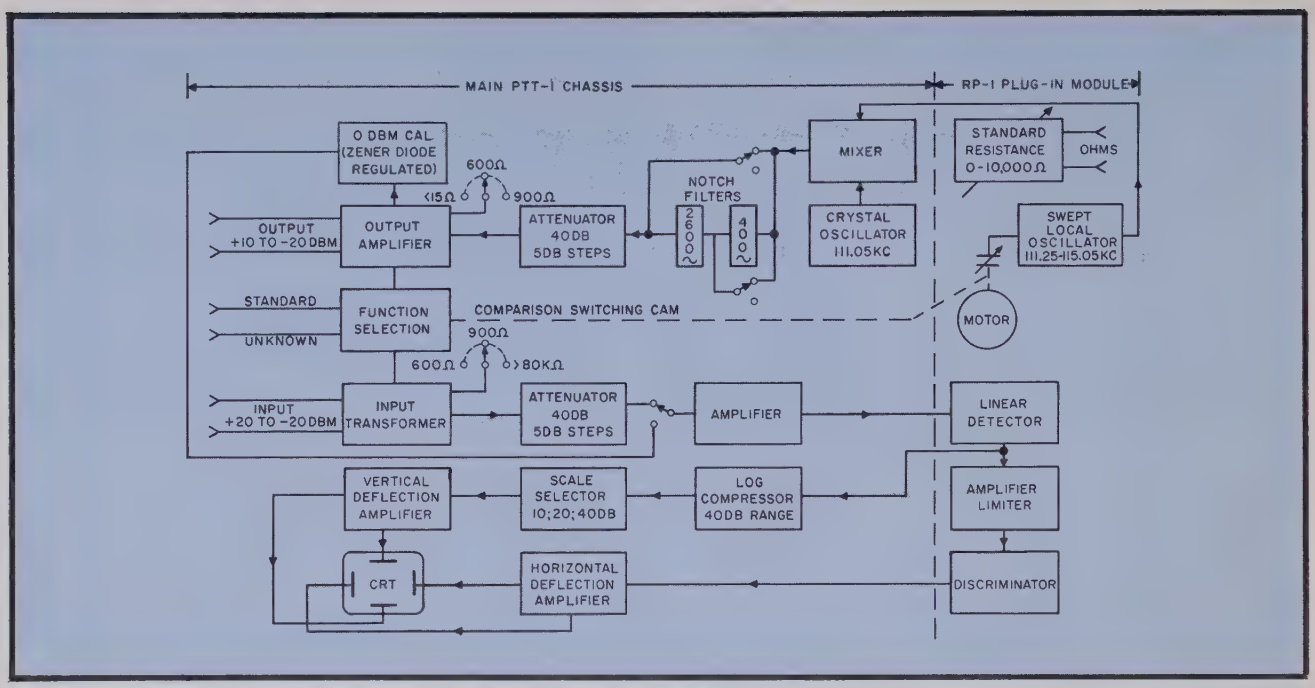
Signal levels in spectrum analyzers are measured by pip height. The scale calibration is selectable among the 0 - 40, 0 - 20, and 0 - 10 db ranges. Residual instrument distortion on spectrum analysis is at least 60 db down. Response to input signals is uniform within ±0.1 db from 200 cps to 4000 cps.



Noise spectrum analysis using SP-1 module over entire 200 cps to 4,000 cps voice band. Signal tone is clearly visible despite high noise background level.

NOISE, SPEECH, DISTORTION ANALYSIS

The SP-1 module is also valuable in monitoring of VF circuits for analysis of noise level distribution, measurement of harmonics, and other distortion down to −60 db, and for speech spectrum studies. The overall 3 second scan from 200 cps to 4 kc provides overall response with resolution capability of approximately 75 cps.



Simplified block diagram of Model PTT-1 with RP-1 module

DESIGN DETAIL

The accompanying block diagrams illustrate the major functional elements of the Model PTT-1 with both the RP-1 and SP-1 plug-in modules. With the RP-1 module, the generator signal is derived from a beat frequency oscillator. A difference beat is obtained in the mixer stage between the frequencies of the variable local oscillator which ranges from 111.25 kc to 115.05 kc and a crystal controlled oscillator output at a frequency of 111.05 kc. Tuning of the local oscillator is controlled by the capacitor trimmer which is automatically rotated every 1.2 seconds or which is operable manually. The taper of the tuning capacitor is arranged to form a logarithmic characteristic of frequency change with angular rotation so that the low end of the output band is scanned relatively slowly. Thus rate of change of frequency is proportioned so that approximately equal amounts of time are spent during the scan of each octave. A log scan velocity generally results in minimum error for swept measurements of lines and networks having appreciable delay distortion.

The swept oscillator includes highly stabilized circuit parameters and has a high Q (figure of merit) to ensure frequency repeatability despite slight changes in temperature and oscillator loading. The modulator output is amplified and low pass band limited to eliminate heterodyne products above 4000 cps, 400 cps and 2600 cps null filters may be inserted in the signal path as shown. The signal frequency stages produce a sine wave output with all distortion components at least 40 db down.

The tuning capacitor, when motor driven, spends an equal amount of time (180°) for forward and return scan during a rotation interval of 1.2 seconds. A cam operated switch coupled to the tuning motor shaft switches terminal connections alternately between the "standard" and "unknown" during comparisons of level and impedance. This switch is cut out of the circuit when only the "unknown" is of interest.

The receiver section circuits of the PTT-1 generate the vertical and horizontal deflection voltage that represents amplitude and frequency on the CRT screen. The horizontal axis deflection with the RP-1 is controlled by a counter type discriminator with DC output proportional to input frequency for the range from 200 cps to 4000 cps. In looped back level tracing, impedance and return loss measurements, the generator output may be connected directly to the discriminator input. With such a local connection, continuous frequency axis tracking is obtained independent of the response of the tested network. In straight-away level measurements of four pole networks, the received signal is fed to the discriminator. The amplifiers and limiters preceding the discriminator provide sufficient input level to obtain reliable discriminator outputs for all input levels within the dynamic range of the instrument.

The received AC signals are detected in the RP-1 and passed through a logarithmic compression amplifier prior to injection into the vertical deflection amplifier. The logarithmic frequency scan velocity also has the advantage of permitting the detector time constant to be progressively decreased with increasing frequency. Near the low frequency end, the time constant is great enough to permit a single line presentation by effectively removing the AC from the envelope all the way down to 200 cps. Near the high end however, the time constant is small enough to follow accurately the rapid variations in envelope amplitude.

The log amplifier is adjustable for 10 db, 20 db, and 40 db ranges. A matrix of back biased diodes which conduct at precisely determined voltages shape the linear detector output into a log characteristic. A 40 db overall curve is obtained and segments of it are used for the 10 db and 20 db scales.

The SP-1 spectrum analyzer and response plotter module includes a double heterodyne swept analyzer with many

pre-set scanning modes and markers for convenience in telegraph channel analysis. A built-in slave sweep frequency generator enables use of the SP-1 for transmission level tracing, impedance and return loss plotting with the spectrum analyzer serving as the receiver-indicator.

Input signals in the 200 cps to 4 kc range are fed to a modulator where they are mixed with the output frequency of a channel selecting switchable local oscillator. The front panel 18 position Channel switch selects, by setting the circuit time constant an oscillator frequency corresponding to a center frequency of telegraph channels between 255 cps and 3145 cps. For the overall sweep range of 200 cps to 4000 cps the center frequency is pre-set at 2100 cps.

The output of the first modulator is passed through a bandpass amplifier to eliminate unwanted mixing products. In the second modulator the output of the bandpass amplifier is mixed with the output of the swept local oscillator and is periodically frequency modulated by the output of the sawtooth generator. The sawtooth generator also drives the frequency axis deflection circuit of the cathode ray tube so that a direct correspondence exists between horizontal position and spectrum analyzer tuning frequency. The sawtooth waveform varies the output capacitance of a FM reactance tube so as to modulate the swept oscillator frequency. At reduced sweep widths of 120 cps and 360 cps, the reactance stage is loosely coupled to the swept local oscillator, improving the frequency stability during highly resolved narrow band analysis.

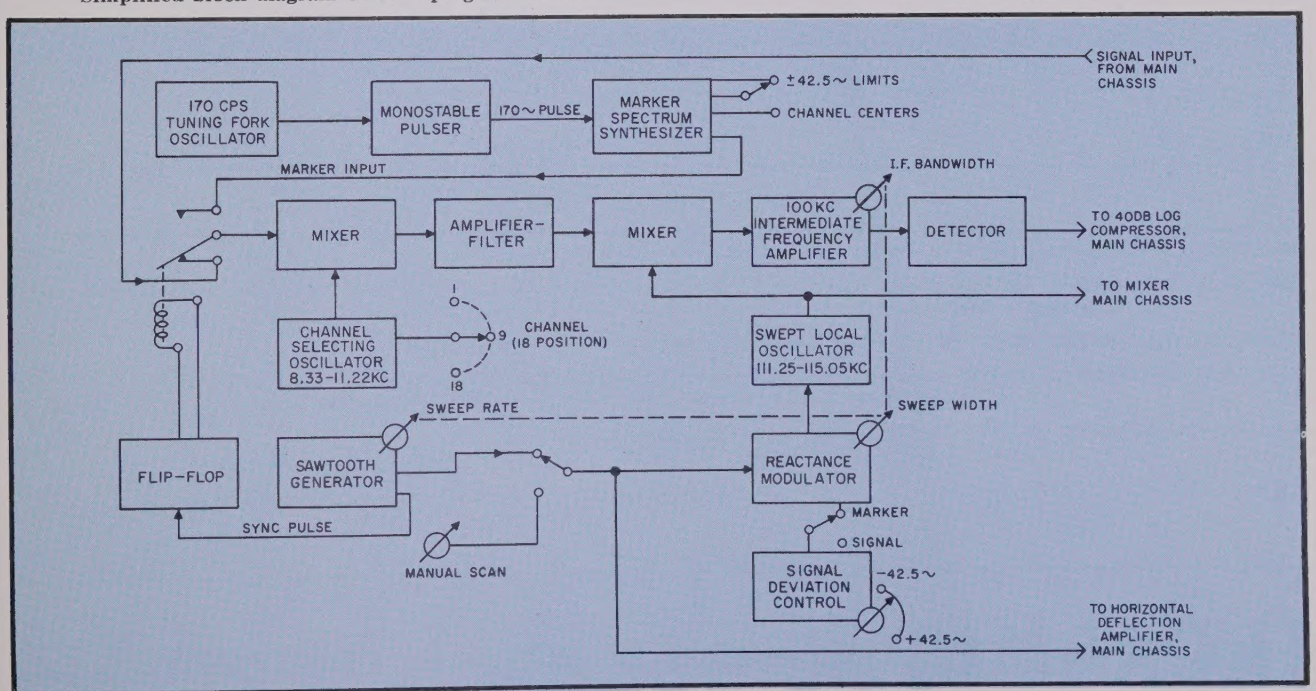
The output of the second modulator is fed to the intermediate frequency amplifiers which furnish additional gain and selectivity. Two crystal filters in cascade are included in the nuvistorized i-f. The loading across the crystal filters is varied by resistors on the multiple section switches which select among the pre-set sweep widths and sweep rates. The bandwidth of the i-f is maintained at the best possible resolution condition for each operating condition. Optimum resolution bears a fixed relationship to the product of sweep width and sweep rate. On the 120 cps and 360 cps sweep widths, the resolution capability permits separation of two equal amplitude signals 20 cps apart. Following the i-f, a linear detector is used to drive the log compressor which is the same one used with the RP-1 module.

The SP-1 includes a unique marker generator which produces reference indications at all center frequencies and ±42.5 cps upper and lower limit frequencies as per standard telegraph signal channels. A tuning fork controlled oscillator at 170 cps generates the highly accurate frequency used in the marker circuits. Its output is formed into a pulse train which is in turn injected into a series of digital divider and adding networks. The marker frequencies are selectable between channel centers which are spaced at 170 cps and the upper and lower limits, spaced at 85 cps. The narrow pulse width used to generate marker frequencies result in equal amplitude marker harmonics throughout the VF band. The markers serve as precise level as well as frequency references.

A bi-stable switch is included in the SP-1 to display the markers and incomig signals on alternate scans. The Signal Deviation control varies the tuning of the swept local oscillator so that the marker and signal pips can be brought into coincidence. This control is calibrated directly in cps so that the deviation in cycles of the marker position from the center frequency or the upper and lower limit is readily measured. For convenience in tests of systems with 70 cps mark-space shifts, ±35 cps calibration reference points are provided on the Signal Deviation control.

To obtain the sweep generator output with the SP-1, its swept local oscillator is fed to the same modulator as is used with the RP-1. Here it is beat with a crystal controlled oscillator which is set at the intermediate frequency to form a difference which is equal to the frequency being "looked at" by the analyzer. The SP-1 analyzer is always tuned to the frequency generated by the companion sweep generator.

Simplified block diagram of SP-1 plug-in module



SPECIFICATIONS, TRANSMISSION MEASURING TEST SET MODEL PTT-1

SPECIFICATION	MODULE RP-1	MODULE SP-1
FREQUENCY RANGE:	200 cps—4000 cps linear scale	200 cps—4 kc, linear scale
SWEEP WIDTHS (FREQUENCY EXCURSION ACROSS SCALE):	3800 cps	120 cps, 360 cps, 3800 cps
CENTER (OF SCALE) FREQUENCIES:	2100 cps	Pre-set at: 2.1 kc for overall scan from 200 cps to 4 kc. Also 255 cps, 425 cps, 595 cps, 765 cps, 935 cps, 1105 cps, 1275 cps, 1445 cps, 1615 cps, 1785 cps, 1955 cps, 2125 cps, 2295 cps, 2465 cps, 2635 cps, 2805 cps, 2975 cps, 3145 cps
SCANNING METHODS:	Automatic bi-directional scanning Manual tuning	Automatic scanning (rapid flyback) Manual, for 200 to 4000 cps range
SCANNING TIMES:	1.2 sec.	1 sec. or 3 sec. for 3800 cps sweep 0.6 sec for 120 cps sweep width 1.8 sec for 360 cps sweep width
OUTPUT LEVELS:	+10 dbm, +5 dbm, 0 dbm, −5 dbm, −10 dbm, −15 dbm, −20 dbm, Re: 600 and 900 ohms	
OUTPUT IMPEDANCE:	Less than 15 ohms, 600 ohms, 900 ohms, balanced or unbalanced	
GENERATOR AND RECEIVER LEVEL DEVIATION:	±0.1 db, re: 1000 cps	Same as RP-1
GENERATOR DISTORTION:	Better than 40 db down from output signal level	
SCALE CALIBRATIONS:		
VERTICAL SCALES:	0-10 db, 0-20 db and 0-40 db linearly distributed. Impedance ranges: 100—1000 ohms, 200—2000 ohms, 400—4000 ohms, (separate screen furnished).	
HORIZONTAL SCALE:	200 cps—4000 cps directly calibrated on linear scale	Same as RP-1 plus linear scale for 120 cps and 360 cps sweep widths
RESOLUTION CAPABILITY (SPECTRUM ANALYSIS):	Not applicable	20 cps on 120 and 360 cps sweep widths
INPUT REQUIRED FOR FULL-SCALE DEFLECTION:	+20 dbm, +15 dbm, +10 dbm, +5 dbm, 0 dbm, −5 dbm, −10 dbm, −15 dbm, −20 dbm Re: 600 and 900 ohms	
MINIMUM USEFUL LEVEL:	−60 dbm	Same as RP-1
UNDISTORTED DYNAMIC RANGE:	Not applicable	60 db on spectrum analysis. Virtually unlimited in response tracing
INPUT IMPEDANCE:	600 ohms, 900 ohms, "High" (more than 80K ohms)	
RETURN LOSS RANGE:	0—60 db	Same as RP-1
CALIBRATION REFERENCES: FREQUENCY:	400 and 2600 cps notch filters	400 and 2600 cps notch filters. Tuning fork controlled marker pips at all telegraph channel center frequencies and markers at ±42.5 cps from center. Signal Deviation control measures frequency separation of input signals from closest marker within ±1 cps.
LEVEL:	Regulated 0 dbm potential re 600 or 900 ohms	
IMPEDANCE:	0—10,000 ohm resistance, ±1% accuracy	

GENERAL SPECIFICATIONS:

DIMENSIONS: Approximately 10" w. x 19⅜" h. x 21" d. with panel cover lid in place.

INDICATOR: Rectangular 6 inch cathode ray tube Type 6AFP7 (high persistence), adjustable scale illumination. Calibrated scale approximately 5¼" x 4¼".

INPUT AND OUTPUT TERMINATIONS: Types 241,309,310, and twin binding posts; multipled.

TRACE RECORDING PROVISIONS: Snap-in pencil transparencies for each CRT scale. (Quantity furnished with PTT-1). Polaroid oscilloscope camera and special mounting bezel (optional).

POWER REQUIREMENTS: 95-130 volts, 60 cps, approximately 150 watts. Approximately 7' long three wire AC line cord permanently connected to front panel.

WEIGHT: Main PTT-1 section: 53 lbs.
RP-1 module: 7 lbs.
SP-1 module: 11 lbs.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

PANORAMIC
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